Natural Channel Design and its Application to Daniels Run, Fairfax, Virginia

Stream Habitat Assessment and Restoration Program
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service

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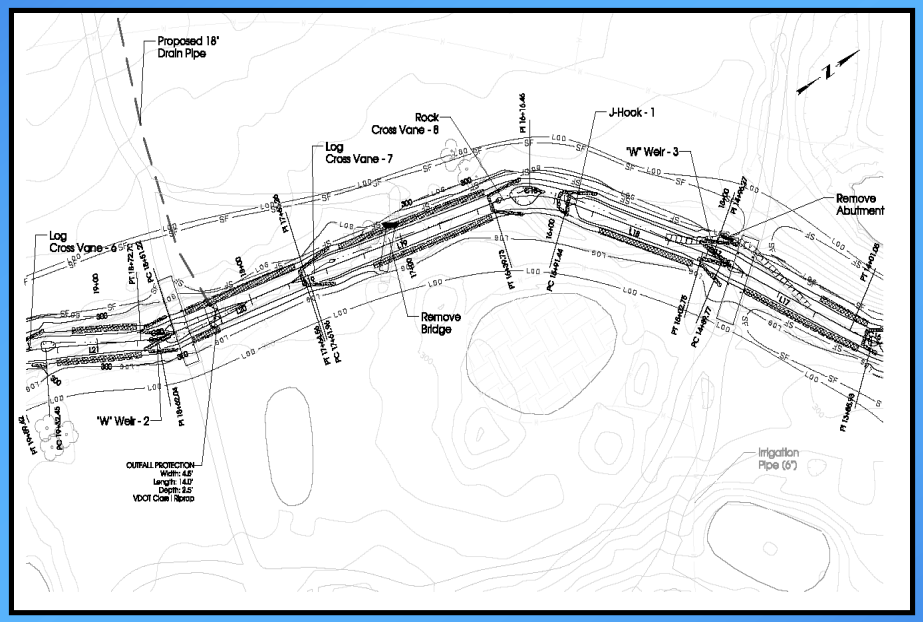
Presentation Overview

- Daniels Run Stream Restoration Project
- Watershed and Stream Assessments
- Natural Channel Design Methodology (NCD)
- Construction Management
- Monitoring

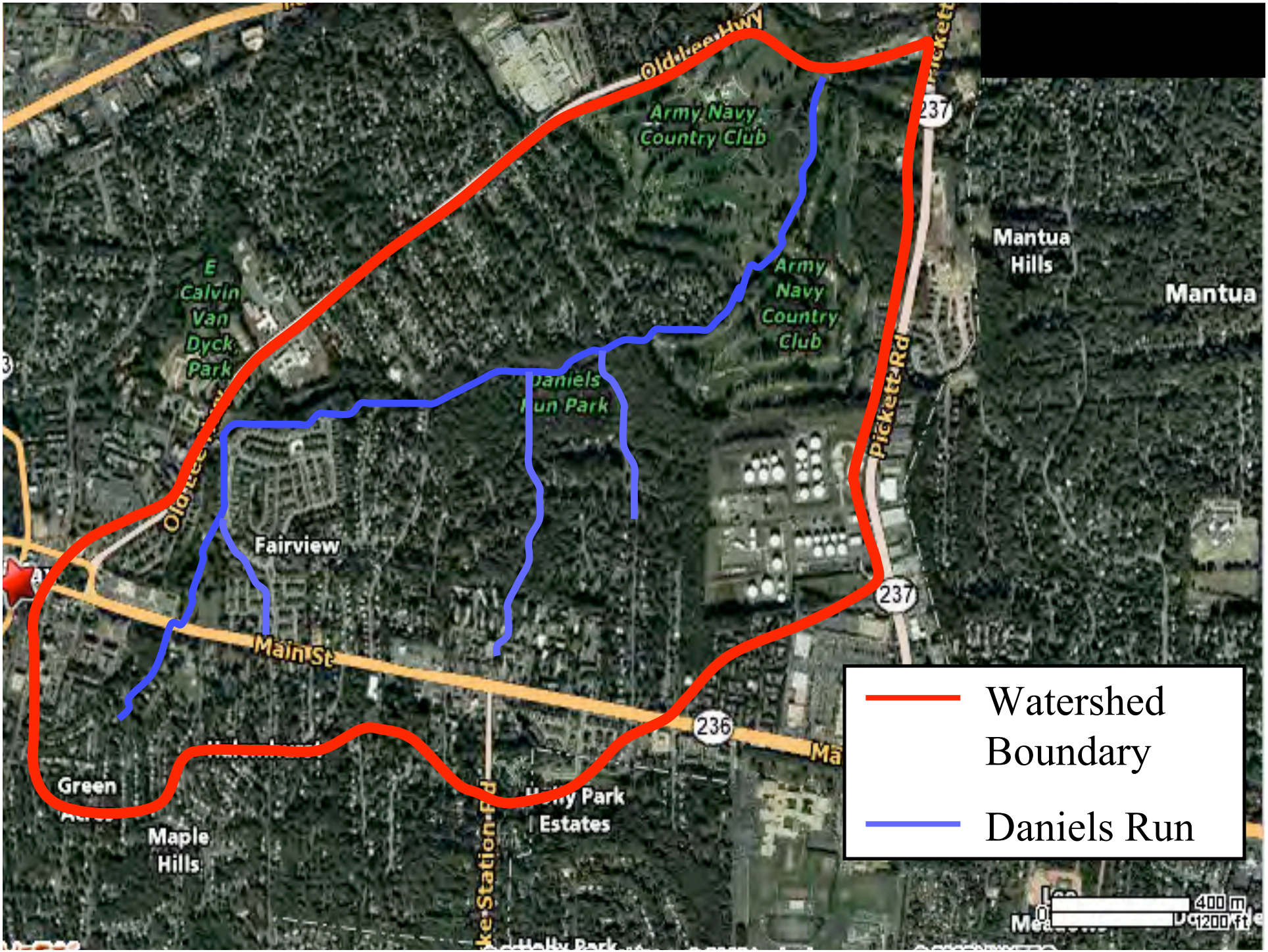


Daniels Runs Stream Restoration Project

- Partnership Between the U.S. Fish and Wildlife Service and Army Navy Country Club (ANCC), Fairfax, Virginia
- Restoration Objective – return 2,500 linear feet of Daniels Run to a stable, self-maintaining state, while meeting the aesthetic and golf playability goals of the Country Club
- Project completed July 2007

Watershed and Stream Assessment

- Watershed Assessment
  - Stream-based and land-based assessments
  - Stream-based - visual assessment of stream character and stability condition
  - Land-based – land use/land cover, geology, soils, hydrology, basin conditions, and development trends
- Stream Assessment
  - Bankfull determination
  - Limited Rosgen Levels II and III
  - Level II – stream type and character (width, depth, pattern, profile, substrate)
  - Level III – stream stability (incision, entrenchment, confinement, vegetation, erosion potential, shear and critical shear stresses, deposition pattern, meander pattern, channel evolution)
- Determine interrelationship of watershed and stream processes ("cause and effect" relationships)


Watershed Boundary
Daniels Run
Army Navy Country Club
Mantua Hills
Mantua
E Calvin Van Dyck Park
Fairview
Main St
Pickett Rd
237
236
Green
Maple Hills
Estates
400 m
1200 ft

Daniels Run Watershed Condition

- Drainage Area – 1.88 square miles
- Rosgen valley type VIII
- Basin relief – 1 percent
- Land use/Land cover - highly developed
  - 45% medium density residential
  - 20% industrial/commercial
  - 35% forested and grass areas (mostly located on ANCC property)
  - Development located in upper two-thirds of watershed
  - New development potential low
- Geology and soils – poorly to moderately well drained
- Hydrology – flashy flow regime due to development, high density storm drains, and lack of flood storage capacity
- Stream Condition – stable to unstable conditions

Stream Condition

- Rosgen Stream Types – Reach 1-C4 and Reach 2-F4
- Approximately 60% banks eroding
- Riparian vegetation – primarily mowed grass
- Widespread instability
- Stability trend - degrading

Natural Channel Design Methodology

- Restoration objectives
- Design criteria
- Form - channel dimension, pattern, and profile
- Process – hydraulic and hydrologic analyses
- Structures
- Iterative Analysis
- Plantings

Natural Channel Design Methodology Definition

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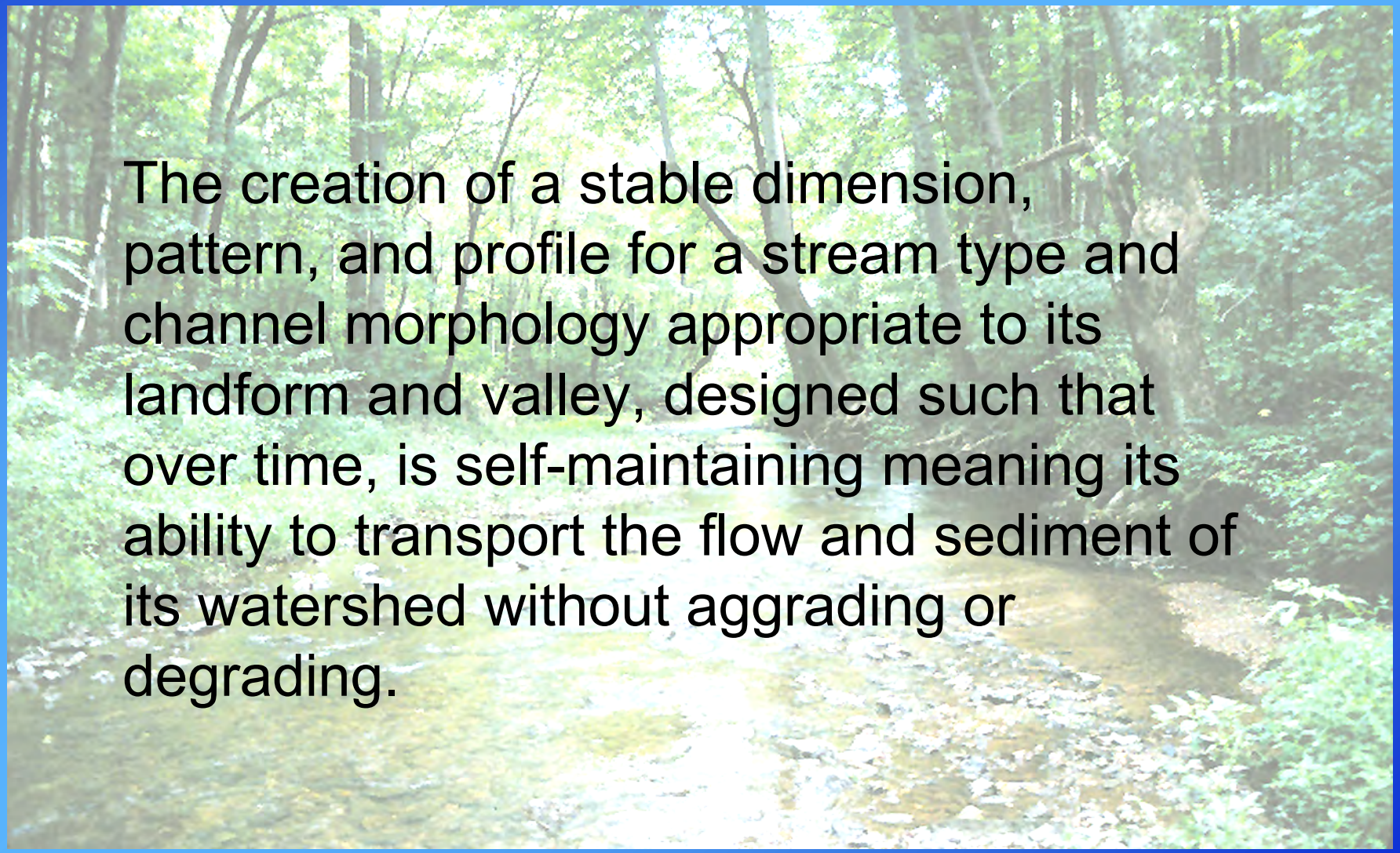


The creation of a stable dimension, pattern, and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time, is self-maintaining meaning its ability to transport the flow and sediment of its watershed without aggrading or degrading.

Daniels Run Restoration Objectives

- Restore a natural, self-sustaining stream
- Apply natural channel design principles
- Maintain golf course playability
- Improve in-stream habitat (*i.e.*, diversity and quality)
- Establish a native riparian buffer without affecting golfing activities
- Improve water quality (*e.g.*, reduce temperatures and sediment)
- Require low maintenance

Restoration Strategy

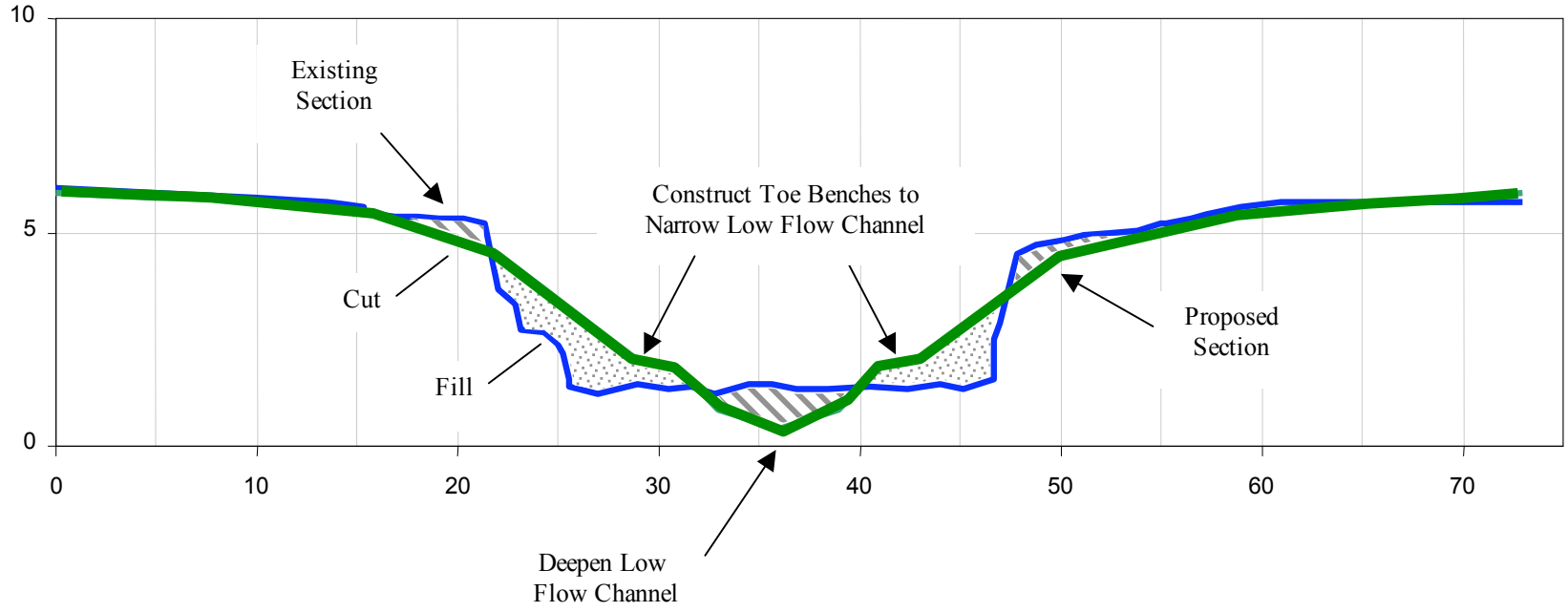
- Total stream reconfiguration
- Two Rosgen stream types – C4 and B4c
- Structures and soil fabric lifts

Design Criteria

- Reference Reach
- Ratios based on bankfull dimensions
- Data range
- Defines channel form and substrate
- Used as monitoring performance measures

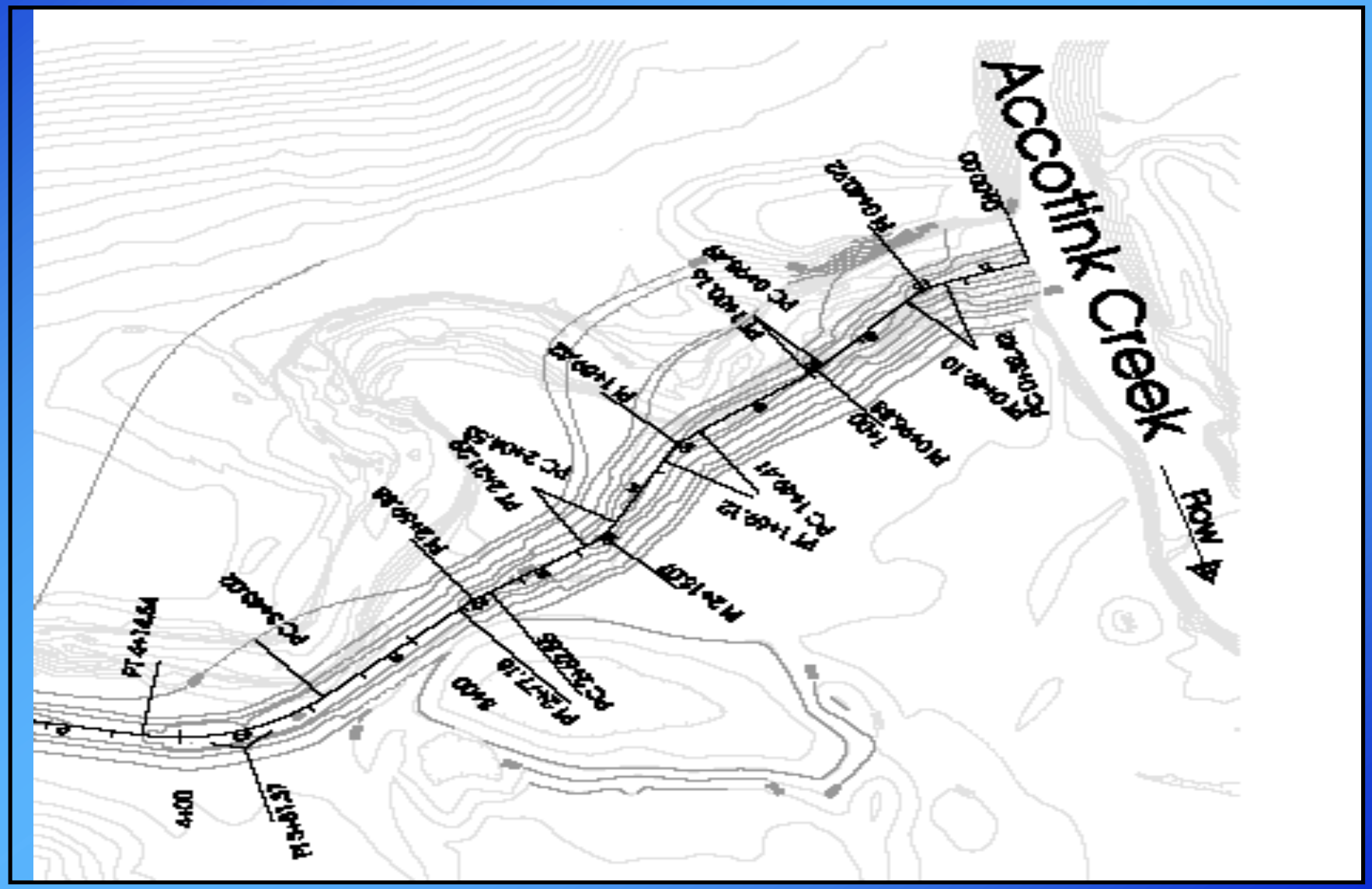
Daniels Run Reference Reach Design Criteria								
No.	Variable	Symbol	Units		Reference Data		Proposed	
1	Stream Type				C4	B4/1c	C4	B4/1c
2	Drainage Area		mi^2	Mean	n/a	27.0	1.9	1.9
				Min	n/a	n/a	n/a	n/a
				Max	n/a	n/a	n/a	n/a
3	Riffle Bankfull Mean Depth	d_{bkf}	ft	Mean	n/a	4.0	1.3	1.4
				Min	n/a	n/a	2.1	1.7
				Max	n/a	n/a	0.7	1.2
4	Riffle Bankfull Width	W_{bkf}	ft	Mean	n/a	44.8	19.0	21.0
				Min	n/a	n/a	n/a	n/a
				Max	n/a	n/a	n/a	n/a
5	Width/Depth Ratio	W/d_{bkf}		Mean	15.0	11.2	15.0	14.6
				Min	9.0	n/a	9.0	12.4
				Max	27.0	n/a	18.0	17.2
6	Riffle Bankfull Cross Sectional Area	A_{bkf}	ft^2	Mean	n/a	179.3	29.3	33.8
				Min	n/a	n/a	n/a	n/a
				Max	n/a	n/a	n/a	n/a
7	Riffle Bankfull Maximum Depth	d_{max}	ft	Mean	n/a	4.7	1.7	2.2
				Max	n/a	n/a	1.9	2.5

Form – Cross Section

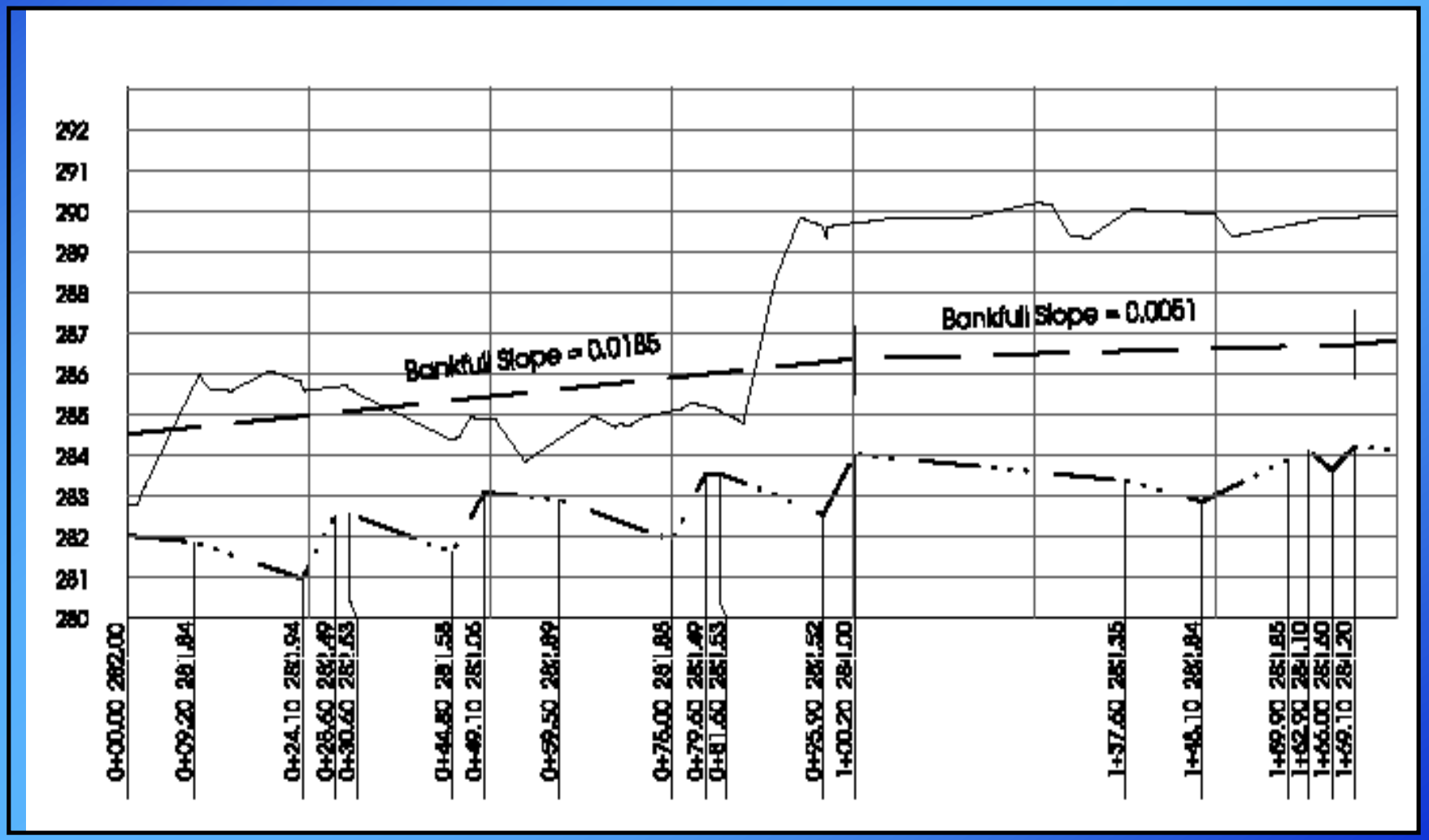


(a) Cross Section Adjustments

Form – Plan Form



Form – Profile

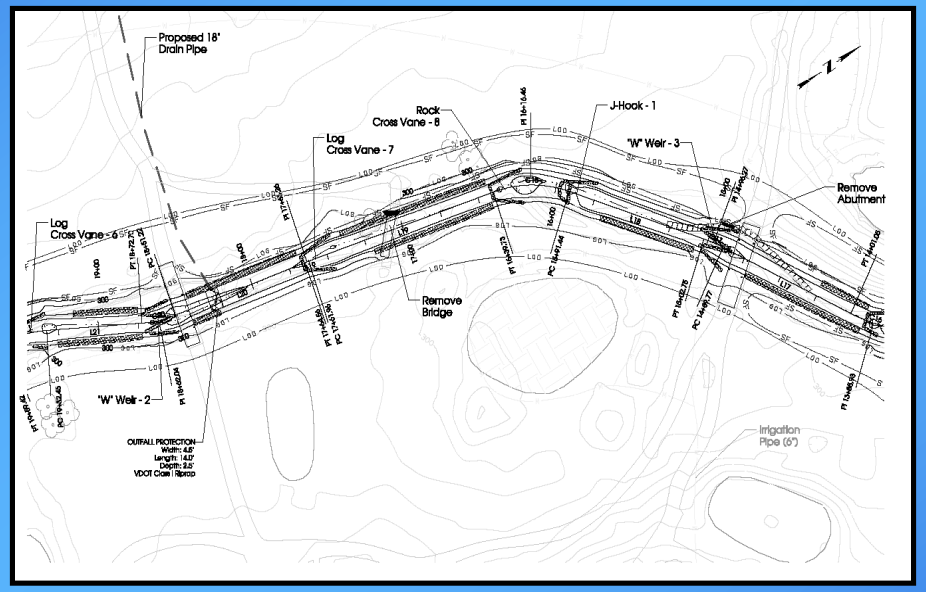


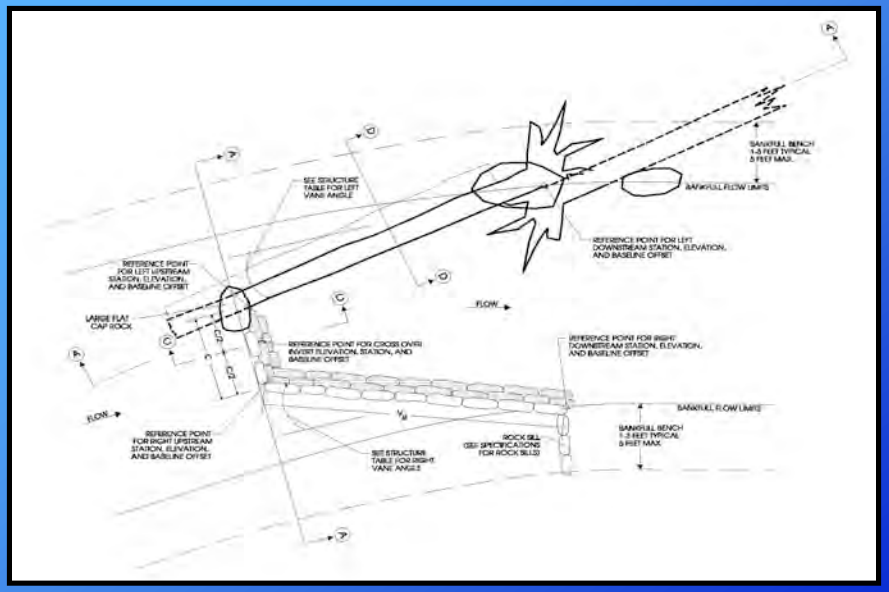
Process – Hydraulic and Hydrologic Analyses

- Sediment transport
  - Critical shear stress analysis
  - Entrainment calculations
  - Modeling
- Flood analysis
  - FEMA
  - 5 yr, 10 yr, 25 yr, and 50 yr

Structures

- Purpose
- Type
- Location





Daniels Run Stream Restoration
Log-Rock Cross Vanes

Daniels Run Stream Restoration
Rock J-hook Vane

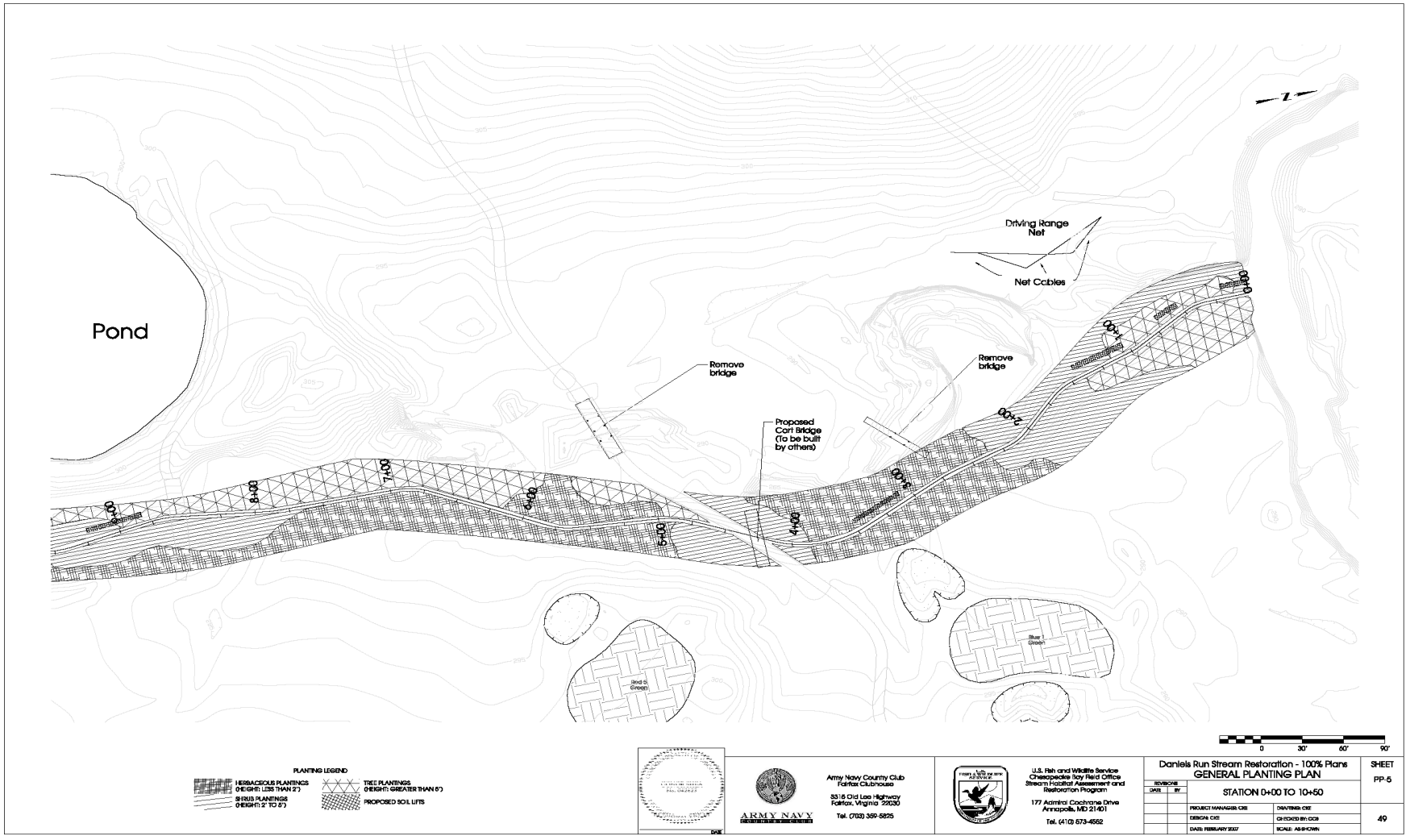
Daniels Run Stream Restoration
Rock W-Weir

Daniels Run Stream Restoration
Soil Lifts

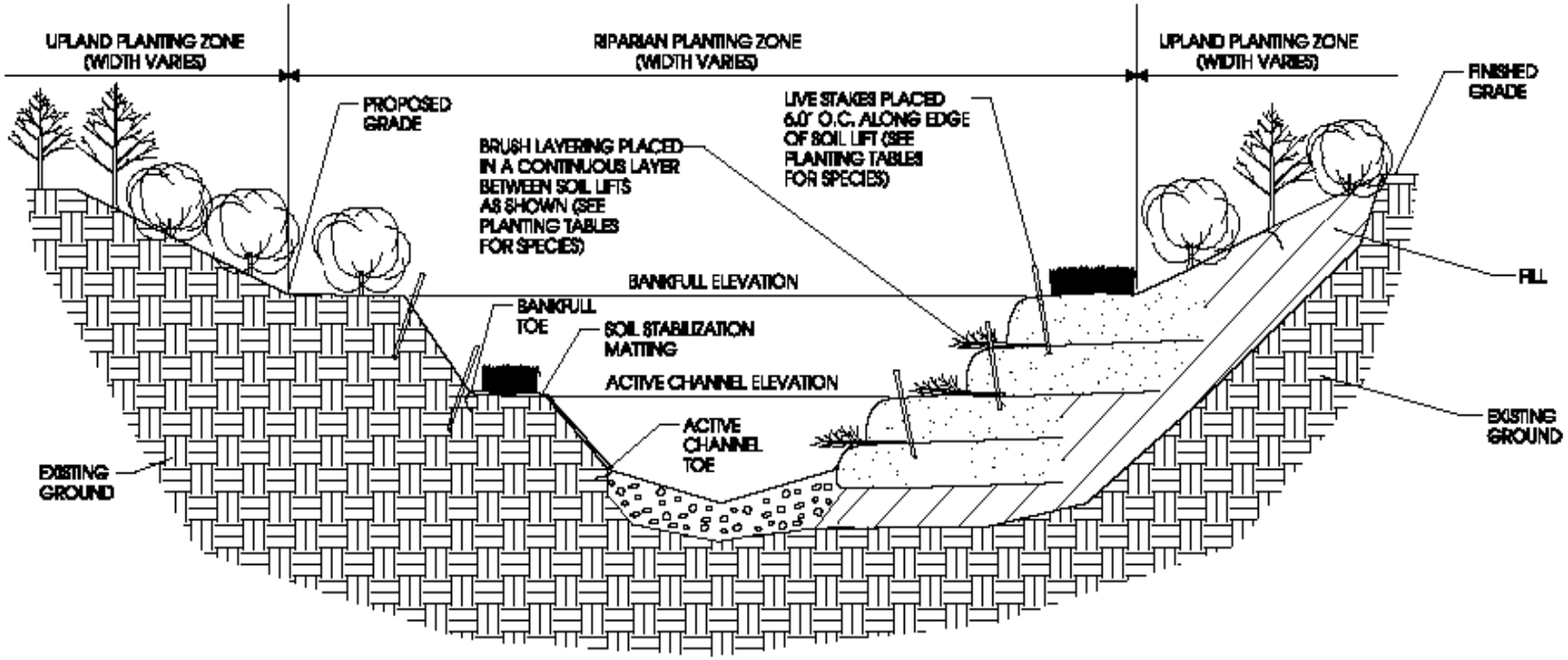
Planting

- Design objectives
- Planting Requirements

Planting Plan



Planting Typical



PLANT SPECIES FOR THE VARIOUS PLANTING ZONES WILL BE SELECTED BASED ON THE PLANT HEIGHT REQUIREMENTS SPECIFIED IN THE PLANTING PLAN.

SOIL LIFT PLANT DETAIL
NOT TO SCALE

Planting

- Design objectives
- Planting Requirements
- Planting zones
- Typicals
- Volunteers

Construction Management

- Stakeout
- Structures
- Grading
- Materials
- Specifications
- Stabilization

Monitoring

- 3 to 5 yrs
- Quantitative performance standards
- As-built drawings
- Monumented cross sections
- Structure evaluation standards
- Photo documentation
- Vegetation success

Daniels Run Stream Restoration
Before and After

Daniels Run Stream Restoration
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Daniels Run Reports and Design:
http://www.fws.gov/chesapeakebay/streampub.htm